Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	

COMMENTS OF VERIZON

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EXECUTIVE SUMMARY

The public interest is best served by a rapid process that clears a substantial amount of 3.7-4.2 GHz spectrum – in the hundreds of megahertz – and assigns it to stakeholders eager to deploy 5G across the country. A market-based mechanism, with Commission oversight, is the most reasonable path to do so, and swift action here to enable the transition will advance U.S. interests in the global race to 5G.

Mid-band Spectrum – and 3.7-4.2 GHz Spectrum in Particular – is Crucial for U.S. Interests in 5G. 5G speeds and low latency will transform every sector of the economy – medicine, transportation, banking, and manufacturing to name a few. And the consumer experience – remote patient monitoring, automated cars, smarter mobile banking, home security, for example – will be forever changed. Mid-band spectrum is critically important for 5G deployment as it will leverage both capacity and coverage opportunities, complementing existing millimeter wave spectrum assets now coming on line.

Across the globe, nations are planning for 5G in mid-band spectrum, as China, South Korea, and Japan among others are committing hundreds of megahertz of 3 GHz spectrum to 5G. But here in the United States, we face a significant mid-band spectrum deficit: by the end of 2018, the United States will rank sixth out of ten countries in terms of mid-band spectrum availability (even accounting for the 3.5 GHz band). The 3.7-4.2 GHz band is the only large swath of new mid-band spectrum that the United States currently is considering.

The Commission is rightly focused on 5G – the 5G FAST plan is unleashing needed spectrum and modernizing infrastructure policy that will help advance U.S. success in the race to 5G. Mid-band is the next step, and the Commission should repurpose as much 3.7-4.2 GHz spectrum as possible as quickly as possible for use in 5G networks.

A Market-Based Mechanism with a Transition Facilitator is the Right Approach. The Commission should allow incumbent satellite operators, working through a "Transition Facilitator," to voluntarily clear 3.7-4.2 GHz spectrum and make repurposed spectrum available on the secondary market, subject to FCC approval. To enable quick action, the Commission should require that satellite providers ensure that qualifying earth station users will continue to have access to the content they currently receive today. Satellite operators are best positioned to protect or accommodate those earth stations interests, given their knowledge and expertise regarding C-band capacity, operations, and use. And bilateral negotiations between the Transition Facilitator and prospective flexible use licensees will provide a degree of flexibility that will help address a complicated transition like this one involving thousands of entities with independent interests.

A Commission-Adopted Repurposing Framework Will Ensure the Transition is Effectuated in the Public Interest. The Commission should subject the market-based mechanism to the following framework:

- The FCC should set a minimum amount of spectrum to be transitioned, in the hundreds of megahertz.
- The FCC should ensure that C-band traffic delivered via existing, qualifying earth stations will be adequately protected or accommodated by the transition.
- The FCC should set strict timelines to accomplish the transition and adopt a backstop – a traditional "clear and auction" approach – in the event of significant delay.
- The FCC should review the transition facilitation plan and promptly act on the transfer of flexible use licenses.

Service and Technical Rules Should Enable Robust 5G Operations. Verizon generally supports the specific proposals put forward for a light-touch, flexible use licensing regime and technical rules harmonized with other flexible use services.

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The global race to 5G is on. And winning this race has tremendous consequences. U.S. leadership in 4G delivered massive benefits to the nation: $100 billion in contributions to the U.S. GDP and $125 billion in revenue to American companies that would have gone elsewhere.[1] Today, the U.S. wireless industry supports more than 4.7 million jobs and contributes $475 billion to the economy each year.[2] Winning the race to 5G promises even greater economic and social benefits. 5G is expected to add more than $500 billion to the U.S. economy and create three million new U.S. jobs.[3] 5G speeds and low latency will transform every sector of the economy – including medicine, transportation, banking and manufacturing – and lead to innovations that are unimaginable today. The consumer experience – remote patient monitoring, automated cars, smarter mobile banking, home security, to name a few – will be forever changed.

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[1] Recon Analytics, *How America's 4G Leadership Propelled the U.S. Economy*, at 1 (Apr. 16, 2018), https://api.ctia.org/wp-content/uploads/2018/04/Recon-Analytics_How-Americas-4G-Leadership-Propelled-US-Economy_2018.pdf.
[2] CTIA, *The Global Race to 5G*, at 4 (Apr. 2018) ("Global Race Report"), https://api.ctia.org/wp-content/uploads/2018/04/Race-to-5G-Report.pdf.
[3] *Id.* at 2.

In 2010, Verizon led the way in 4G with the world's first large-scale 4G LTE network, and today we are blazing the trail with 5G. Earlier this month, using millimeter wave spectrum, Verizon launched the world's first commercial 5G offering – a fixed wireless broadband service with peak speeds approaching 1 Gbps in Houston, Indianapolis, Los Angeles, and Sacramento.[4] Verizon will continue to extend this new 5G service to other markets and will deploy mobile 5G as soon as the equipment is available. Access to a substantial amount of mid-band spectrum will help Verizon and others quickly extend the promise of 5G.

I. PROMPT REPURPOSING OF 3.7-4.2 GHz SPECTRUM IS CRUCIAL FOR U.S. INTERESTS IN THE RACE TO 5G.

The Commission is rightly focused on 5G – the 5G FAST plan is unleashing spectrum and modernizing infrastructure policy that will foster continued U.S. global leadership in wireless and help advance U.S. success in the race to 5G.[5] As Chairman Pai recently noted, "[o]n spectrum, the FCC has been extremely aggressive. We're making more airwaves available for the commercial marketplace in the low-, mid-, and high-bands."[6] The Commission has been particularly active in making available a significant amount of millimeter wave spectrum and in scheduling the first auctions of this spectrum, beginning next month. But as China, South Korea, and Japan commit hundreds of megahertz of mid-band spectrum to 5G, the United States faces a significant mid-band spectrum deficit: by the end of 2018, the United States will rank sixth out

[4] Press Release, Verizon, *Verizon turns on world's first 5G network* (Oct. 1, 2018), https://www.verizon.com/about/news/verizon-turns-worlds-first-5g-network; Press Release, Verizon, *5G is here* (Sept. 11, 2018), https://www.verizon.com/about/news/5g-here.
[5] FCC, *The FCC's 5G FAST Plan* (Sept. 28, 2018), https://docs.fcc.gov/public/attachments/-DOC-354326A1.pdf.
[6] Ajit Pai, Chairman, FCC, Remarks at the 7th Annual Americas Spectrum Management Conference, Washington, DC, at 2 (Oct. 3, 2018).

of ten countries in terms of mid-band spectrum availability (even accounting for the 3.5 GHz band).[7]

Mid-band spectrum is critically important for 5G deployment as it will leverage both capacity and coverage opportunities. As nations across the globe plan for 5G in mid-band spectrum, and the 3 GHz band in particular, wireless broadband providers in the United States need access to more mid-band spectrum to lead in 5G. While the recent CBRS Order was a positive step and will open the opportunity for 5G in the 3.5 GHz band, the 3.7-4.2 GHz band is the only large swath of new mid-band spectrum that the United States currently is considering. The Commission should thus fuel 5G by repurposing as much 3.7-4.2 GHz spectrum as possible as quickly as possible for flexible use.

II. COMMISSION ACTION TO REPURPOSE 3.7-4.2 GHz SPECTRUM SHOULD ENSURE A SWIFT TRANSITION OF SIGNIFICANT SPECTRUM AND FAIR TREATMENT OF INCUMBENT EARTH STATIONS AND NEW MID-BAND FLEXIBLE USE BIDDERS ALIKE.

Verizon supports the Commission's goal "to promote the rapid deployment of new licensed terrestrial operations in the 3.7-4.2 GHz band."[8] To achieve this goal, the Commission should promptly act on this rulemaking, taking into account the following principles:

Repurpose a Significant Swath of Spectrum and Rapidly Transition the Band. For the United States, the path to maintain global leadership in wireless goes through 5G, and to win the race to 5G, the United States must quickly introduce a significant swath of licensed, flexible use mid-band spectrum. Several hundred megahertz of the 3.7-4.2 GHz band would complement existing millimeter wave spectrum assets now coming on line. The millimeter wave spectrum offers high capacity and a robust 5G experience, but faces inherent limitations on propagation.

[7] Global Race Report at 11.
[8] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Order and Notice of Proposed Rulemaking, FCC 18-91, ¶ 97 (rel. July 13, 2018) ("*Notice*").

Complementing that spectrum with mid-band spectrum will allow wireless broadband providers to extend 5G network coverage using both mid-band and millimeter wave frequencies. Other nations are already assigning licenses of 100 megahertz each in the 3 GHz band,[9] and the United States should take decisive action here to avoid being left behind. To put it simply, the Commission should make similarly large swaths of mid-band spectrum available for 5G providers here. The Commission should adopt a mechanism best equipped to facilitate a quick transition.

Ensure the Continued Delivery of Current C-Band Traffic. To act quickly here, the Commission should require that the C-band satellite operators provide unequivocal assurances that with the clearing of 3.7-4.2 GHz spectrum, C-band earth station users, like Verizon, will continue to have access to the content they currently receive today. As satellite operators have noted, they fully intend to provide continuity of services to their earth station customers.[10]

III. THE MARKET-BASED MECHANISM, WITH COMMISSION OVERSIGHT, IS THE MOST REASONABLE PATH TO TRANSITION 3.7-4.2 GHz SPECTRUM.

A. The Market-Based Mechanism with a Satellite Transition Facilitator to Clear Spectrum and Reach Agreements with Prospective Licensees Appears to be the Right Approach

1. The Market-Based Mechanism Offers Significant Benefits

The market-based mechanism is the most fully evaluated approach in the *Notice* and offers a meaningful basis to swiftly transition a significant swath of spectrum while addressing

[9] *See N*, Monica Alleven, *South Korea wraps 5G auction for 3.5, 28 GHz*, FierceWireless (June 20, 2018), https://www.fiercewireless.com/wireless/south-korea-wraps-5g-auction-for-3-5-28-ghz (South Korea auctioned 280 MHz in the 3.5 GHz band to three companies); Pete Bell, *Italian 5G Auction Sees High Price Tags, Raised Eyebrows*, TeleGeography (Oct. 15, 2018), https://blog.telegeography.com/italian-5g-auction-causes-concern (Italy recently auctioned 200 MHz in 3.6-3.8 GHz with a 100 MHz cap per operator).

[10] *See, e.g.*, Letter from Jennifer D. Hindin, Counsel for the C-Band Alliance, to Marlene H. Dortch, Secretary, FCC, Attachment (filed Oct. 17, 2018) (committing to provide C-Band operators with "the quality, reliability and certainty [needed] to successfully operate and grow.").

the various stakeholders' key interests. With underpinnings grounded in the approach put forward by Intelsat, SES, and Intel, the *Notice* envisions that the Commission would authorize incumbent satellite operators "to voluntarily clear all or part of the band" and "make spectrum available to terrestrial operators on the secondary market."[11] The satellite operators would designate a "Transition Facilitator" responsible for clearing the band, protecting or accommodating qualifying earth stations, negotiating with prospective flexible use licensees, and repacking the band.[12]

In a paper attached to these comments, Professor Daniel Vincent explains the key benefits of the market-based mechanism. As the *Notice* recognizes, the secondary market-based approach likely will clear the band and assign spectrum rights more quickly than other mechanisms, such as an FCC-led auction.[13] In particular, the Transition Facilitator will be very well positioned to clear 3.7-4.2 GHz spectrum and reach arrangements with prospective mid-band flexible use licensees. Satellite operators, through the Transition Facilitator, can leverage their knowledge and expertise regarding C-band capacity, operations, and use, and they will have appropriate incentives to clear incumbent users.

Bilateral negotiations between the Transition Facilitator and prospective flexible use licensees also will provide a degree of flexibility that will help address a complicated transition like this one involving thousands of entities with independent interests. This flexibility can lead to more efficient outcomes, for example:

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[11] *Notice* ¶ 66.

[12] *Id.* ¶ 70. On October 1, 2018, Intelsat, SES, Eutelsat, and Telesat announced the formation of the C-Band Alliance "to fulfill the role of a 'Transition Facilitator,'" as described in the *Notice.* *See* Caleb Henry, *Telesat changes tune, joins C-band spectrum group*, SpaceNews (Oct. 1, 2018) https://spacenews.com/telesat-changes-tune-joins-c-band-spectrum-group/.

[13] Prof. Daniel R. Vincent, Assessment of Proposed C-Band Mechanisms, at 2 (Oct. 22, 2018) ("Vincent") (attached hereto); *Notice* ¶ 67.

> [O]ne buyer might be willing to pay significantly more for spectrum in a [PEA] if it can be cleared very quickly, and another might be willing to wait for a longer period in return for a lower price. … The costs and difficulties of clearing spectrum could help determine which buyer would be appropriate.[14]

Bilateral negotiations would thus enable meaningful individualized agreements that take into account different clearing realities and priorities of individual bidders in a way that system-driven approaches such as auctions cannot address.

Further, as the *Notice* recognizes, the market-based mechanism is well situated to repurpose a significant swath of spectrum quickly, to be followed by more tranches of additional 3.7-4.2 GHz spectrum.[15] The Commission must ensure an initial transition of significant spectrum but should also embrace a mechanism that will foster further repurposing down the road.

Finally, as Professor Vincent notes, "this approach requires relatively little intervention or rule-making by the FCC and, for that reason, might be expected to conclude much more quickly."[16] As noted above, swift action here is critical to U.S. prospects in the race to 5G, and the market-based mechanism offers the best prospects for action next year.

2. Other Approaches are Less Optimal

The *Notice* also seeks comment on alternative mechanisms to repurpose 3.7-4.2 GHz spectrum but, as Dr. Vincent concludes, each has disadvantages that are likely to make them less successful than the market-based mechanism in quickly repurposing a significant amount of spectrum.

[14] Vincent at 3.
[15] *Id.*
[16] *Id.*

T-Mobile's "hybrid" proposal combines some aspects of the market-based mechanism with an auction that resembles the Commission's Incentive Auction of broadcast spectrum, but it would reverse that auction process, so that the forward auction would be conducted *first* and C-band satellite operators would then "bid" to supply a given amount of spectrum.[17] But Dr. Vincent observes that an FCC-conducted auction is less flexible than the market-based mechanism. For example, it would be difficult for the auction to accommodate the many different spectrum products that would vary by the degree of encumbrance or the timing of clearance in each license area.[18] The hybrid model would also generate uncertainty for wireless bidders, because, as Dr. Vincent notes, "[b]uyers with specific footprint targets may have difficulty determining how much to bid in early stages of the auction since they cannot be sure of how much spectrum ultimately will be cleared."[19] That uncertainty could suppress interest in the auction, resulting in insufficient spectrum being cleared to enable robust 5G deployment.

The various FCC-conducted auction mechanisms the *Notice* identifies also have disadvantages compared to the market-based mechanism. The *Notice* provides little detail in how the auctions would operate or how they could result in optimal repurposing of C-band spectrum.

The incentive auction model is problematic in this context because, unlike the broadcasters supplying spectrum in the broadcast incentive auction, each of the potential suppliers of C-band spectrum owns rights to *all* of the spectrum (i.e., each holds rights to transmit across all 500 megahertz in the 3.7-4.2 GHz band), making it difficult to see how the

[17] *Notice* ¶ 112.
[18] Vincent at 5.
[19] *Id.*

reverse portion of the auction could work.[20] Dr. Vincent labels an incentive auction model as an "experiment" and concludes, "[f]or reasons of sheer complexity, it is unlikely that a sophisticated mechanism like this could work on, say, a geographic area by area basis, so many compromises would have to be made to render it implementable."[21]

In an "overlay" auction, the successful bidder(s) would negotiate with incumbents (rather than the single Transition Facilitator).[22] As Dr. Vincent points out, the serious flaw with this model is that, having already agreed to pay for a license, the bidder could only recoup its investment if each of the incumbents agrees to vacate that part of the band, but nothing would compel them to do so. He concludes that overlay licensees may need to anticipate "hold-up strategies by the incumbent licensees," which "could result in an unwillingness for prospective overlay licensees to risk an upfront investment of any sort in the overlay auction."[23]

Under the final model in the *Notice*, a "capacity" auction, users of C-band capacity would cede capacity by, for example, transitioning to other delivery systems or migrating to a different band.[24] But Dr. Vincent observes that this model "replaces one auction related problem with another problem that is familiar from the package auctions – the threshold problem," where no licensee has the incentive to be the first to offer capacity.[25] And a capacity auction model would require extensive Commission intervention by, among other things, likely compelling incumbents to vacate their spectrum. The capacity auction relies on Commission regulation rather than market-based incentives.

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[20] *Notice* ¶¶ 103-05.
[21] Vincent at 7.
[22] *Notice* ¶¶ 99-102.
[23] Vincent at 7.
[24] *Notice* ¶¶ 106-08.
[25] Vincent at 9.

In sum, the market-based mechanism has the advantage of providing the most flexibility for interested spectrum sellers and buyers to reach mutually beneficial agreements. By contrast, the alternative models are not well-suited to the way spectrum is held and used in the C-band, and rely on various degrees of Commission regulation and involvement, which will likely delay repurposing the spectrum and lead to less efficient outcomes than the market-based mechanism.

B. A Commission-Adopted Repurposing Framework Will Ensure the Transition is Effectuated in the Public Interest

1. The FCC Should Ensure that Hundreds of Megahertz of Spectrum Is Transitioned to Flexible Use

The Commission should "require that an Initial Minimum Spectrum Benchmark – a socially efficient amount of spectrum – be repurposed in the band."[26] And to be clear, with other nations assigning 3 GHz licenses of 100 megahertz each, [27] the Commission should require an Initial Minimum Spectrum Benchmark greater than the C-Band Alliance's recent proposal of 200

[26] *Notice* ¶ 81.

[27] David Abecassis, Chris Nickerson, and Janette Stewart, *Global Race to 5G – Spectrum and Infrastructure Plans and Priorities*, at 14, Analysys Mason (Apr. 2018), https://ecfsapi.-fcc.gov/file/10417556600122/Analysys%20Mason%20Global%20Race%20To%205G%20Report.pdf; Sean Kinney, Update on global 5G spectrum auctions, RCR Wireless News (Aug. 21, 2018), https://www.rcr-wireless.com/20180821/5g/5g-spectrum-auctions (awarding licenses in South Korea in the 3.5 GHz range of 100 megahertz, 100 megahertz, and 80 megahertz); Germany's Federal Network Agency, *President's Chamber decision of 14 May 2018 on the order for and choice of proceedings for the award of spectrum in the 2 GHz and 3.6 GHz bands for mobile/fixed communication networks (MFCN)*, at 29 (May 14, 2018), https://www.bun-desnetzagentur.de-/SharedDocs/Downloads/EN/Areas/Telecommunications/Companies/-TelecomRegulation/FrequencyManagement/ElectronicCommunicationsServices/FrequencyAward2018/20180613_Decision_I_II.pdf?__blob=publicationFile&v=1 (providing for 300 megahertz nationwide assignments between 3400-3700 MHz and up to 100 MHz for regional and local assignments and noting that "bidders will be able to decide to acquire more or less than 100 megahertz to put their own business models into practice"); Ireland's Commission for Communications Regulations, Results of the 3.6 GHz Band Spectrum Award; Information Notice, at 5 (May 22, 2017), https://www.com-reg.ie/media/dlm_uploads/2017/05/ComReg-1738.pdf (announcing in Ireland's 3.6 GHz auction Three Ireland Hutchinson Ltd. obtained 100 MHz nationally).

megahertz. That proposal is significantly better than the 100 megahertz originally offered, but the Commission should require the Transition Facilitator to clear more than that amount.

2. The FCC Should Ensure that C-Band Traffic Delivered Via Qualifying Earth Stations Will Be Adequately Protected or Accommodated by the Transition

a. The FCC Should Identify Earth Stations that Will be Protected and Clarify the Status of Other Services

The Commission should ensure that the Transition Facilitator will protect or accommodate today's C-band traffic. It should draw clear lines about other services in the band, providing certainty about the Transition Facilitator's clearing responsibilities and about opportunities for new flexible use licensees. Below we address the rights of earth station owners and operators, licensed point-to-point fixed service ("FS") licensees, and space station operators in the 3.7-4.2 GHz band.

Identify and Define Protected Earth Stations. With a clear understanding of earth station operating rights, stakeholders can determine how best to meet existing C-band satellite uses and maximize the amount of spectrum to be repurposed. As a result, identifying the category of earth stations that qualify for protection as part of the transition is a critical step in providing stakeholders with a roadmap for repurposing the band. Verizon supports the Commission's proposal to define earth stations as (i) those facilities that were operational as of April 19, 2018, (ii) that are licensed or registered or have a pending application for a license or registration in the IBFS database as of October 31, 2018, *and* (iii) whose owners have timely certified the accuracy of information on file in IBFS.[28]

[28] *Notice* ¶ 27; *International Bureau Announces Two-Week Extension of Filing Window for Earth Stations Currently Operating in 3.7-4.2 GHz Band*, Public Notice, DA 18-1061 (rel. Oct. 17, 2018).

Terminate Registrations or Licenses for Uncertified Earth Stations and Delete Unused Earth Station Data. The Commission should automatically terminate the registration or license of any earth station that does not comply with the requirement to certify as to the accuracy of all information in IBFS concerning the earth station's operations.[29] Similarly, the Commission should delete any combination of frequency, azimuth, and elevation listed in a license or registration that is unused for more than 180 days,[30] consistent with the 180-day discontinuance of service rule that applies to Wireless Radio Services.[31] To that end, earth station licensees and registrants should certify annually to the continued accuracy of the information on file with the Commission.[32] These rules will serve to ensure the accuracy and operational status of protected 3.7-4.2 GHz band earth stations, clear the IBFS database of misidentified or dormant facilities, and simplify the process of repurposing the spectrum.

Replace the Full-Band, Full-Arc Coordination Policy. The Commission should replace the full-band, full-arc coordination policy with a new approach that grants protection for "those frequencies, azimuths and elevation angles and other parameters reported as in regular use (i.e., at least daily)."[33] This approach recognizes the spectrally inefficient nature of the full-band, full-arc policy, resulting in fallow spectrum where other operations would not cause harmful

[29] *Notice* ¶ 34.
[30] *Id.* ¶ 35.
[31] *See Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95 and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services,* Second Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 8874, 8897-98 ¶ 60 (2017) ("*Wireless Reform Order*").
[32] *Notice* ¶ 36.
[33] *Id.* ¶ 39.

interference. The Commission's proposal will help achieve the goal of maximizing spectrum efficiency and more intensive use of the 3.7-4.2 GHz band.[34]

Prohibit New Space Station Operators. The Commission should also clarify the status of future space station operations in the 3.7-4.2 GHz band and should, as proposed in the *Notice,* bar new applications for space station licenses and new petitions for market access concerning space-to-Earth operations in the 3.7-4.2 GHz band.[35] This action will nonetheless preserve the rights of existing space station operators to file applications for extension, replacement or modifications of existing authorizations and apply for new space stations where such stations "would promote more efficient use of the band."[36]

Sunset Fixed Service Operations. The Commission should sunset the remaining few point-to-point fixed service operations in the 3.7-4.2 GHz band (115 licenses in total) and should adopt a two-year sunset period.[37] Two years is ample time given "the availability of other spectrum options for point-to-point links."[38] As the Commission notes, these licenses can either be cancelled or modified to operate on a non-interference basis. This action will speed repurposing the spectrum and thus advances the objectives of this proceeding.

b. Numerous Options are Available to Ensure Continued Delivery of Today's C-Band Traffic

Repurposing 3.7-4.2 GHz spectrum will require that today's C-band traffic delivered over protected earth stations be protected or accommodated – and there are multiple options. "Protected" status could mean that the traffic is moved to a different transponder on the same satellite or on a different satellite, is moved from the C-band to different frequencies such as the

[34] *Id.*
[35] *Id.* ¶ 46.
[36] *Id.*
[37] *Id.* ¶ 48.
[38] *Id.*

Ku-Band, is moved to fiber and delivered to the same destination of the earth station, or any number of other options including use of updated compression technology.

The Transition Facilitator is in the best position to "ensure that protected incumbent earth stations continue to have access to the content or bandwidth they currently receive using C-band earth stations today."[39] The satellite operators know the existing traffic patterns and contracts, and the available C-band capacity options. Further, their incentives should align well with swiftly and effectively accommodating protected earth station traffic in order to free up spectrum. As a result, the Commission need not adopt rigorous requirements but can assist the transition by identifying appropriate options for stakeholders to consider.[40] Options include:

Repack the C-Band. Evidence in the record shows that the C-band is not efficiently utilized today, and repacking earth station operations into a smaller portion of the C-band is the simplest solution to free up 3.7-4.2 GHz frequencies for more terrestrial use.[41] Traffic could be moved to different transponders located on frequencies higher up in the band either on the same satellite or on a satellite located in a different orbital slot. As discussed above, the full-arc, full-band policy would need to be modified so that earth station interference protection rights would be extinguished in the newly vacated portion of the band.

Relocate to Different Spectrum. Today's C-band traffic could also be delivered via different frequencies, such as the Ku-band. One concern about the Ku-band has been the effects of rain fade, but systems can be engineered to mitigate those effects by, for example, using

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[39] *Id.* ¶ 79.
[40] *Id.* ¶ 85.
[41] *See, e.g.*, Comments of Competitive Carriers Association, GN Docket No. 17-183, at 2 (filed Aug. 7, 2017), Comments of CTIA, GN Docket No. 17-183, at 8 (filed Oct. 2, 2017) ("CTIA Comments"), Comments of Dynamic Spectrum Alliance, GN Docket No. 17-183, at 6 (filed Oct. 2, 2017), Comments of the Broadband Access Coalition, GN Docket No. 17-183, at 6 (filed Oct. 2, 2017).

multiple earth station sites to avoid the localized impact of heavy rain.[42] These capabilities could significantly reduce concerns and open up additional opportunities for content distribution over Ku-band frequencies.

Replace Satellite Connections with Fiber, or Use Remote Earth Station + Fiber Delivery. Much C-band traffic can be transitioned to fiber where fiber is readily available, particularly in urban or suburban areas. Fiber offers lower latency than C-band connectivity, greater capacity, and greater security from radio frequency (RF) interference. And fiber is increasingly available. Studies that T-Mobile filed in the record, for example, use two cities, Chicago and Phoenix, to show it is feasible to eliminate all earth stations operations while ensuring uninterrupted delivery of all traffic currently received via those earth stations.[43] The Chicago study identified multiple fiber providers covering 80 percent of the area and concluded that replacing earth stations with fiber as well using as the options studied in Phoenix could clear all earth stations at a cost of only $8 million – a small amount compared to the value of 500 megahertz of mid-band spectrum in that market.[44]

Alternatively, C-band customers can rely on earth stations located in remote, less populated areas where harmful interference from new terrestrial operations is far less likely, with traffic delivered via fiber from the remote site to desired locations. The record shows that this approach is already in use for major teleport services offered by Intelsat and other satellite

[42] CTIA Comments at 10-11 (noting advantages of Ku-band transmission over the C-band); Reply Comments of Verizon, GN Docket No. 17-183, at 10-11 (filed Nov. 15, 2017) (citing engineering studies on mitigating rain fade in Ku-band).
[43] Letter from Steve B. Sharkey, Vice President, Government Affairs Technology and Engineering Policy, T-Mobile, to Marlene H. Dortch, FCC, GN Docket No. 17-183 (filed June 15, 2018) ("T-Mobile June 15 ex parte"), attaching Phoenix Earth Station Relocation Study (May 30, 2018) and Mid-band Assessment: Cost Factors Affecting Fiber as an Alternative to Satellite (June 14, 2018).
[44] T-Mobile June 15 Ex Parte at 4.

operators.[45] Closer to home, Verizon's experience validates the approach of using a fiber delivery approach with the earth stations. As an MVPD, Verizon relies on delivery of video content to its head-ends just like others in the marketplace. Yet, rather than build a headend in each market, Verizon built two "super" headends to receive content via satellite and uses fiber to distribute the feeds to each sub-tending market. And the Phoenix study that T-Mobile commissioned demonstrates that this approach could be effective for an entire market: all earth stations within 60 kilometers of the Phoenix Cellular Market Area can replaced and all traffic can be delivered, either by backhauling traffic from existing earth stations outside that radius using fiber, or by constructing a new antenna farm and then backhauling traffic.[46]

Deploy Compression Technology. Another option available to the Transition Facilitator is to migrate C-band traffic from MPEG-2 to MPEG-4 or the more compressed HEVC technology. By deploying new compression technology at earth stations (receive and transmit), the Transition Facilitator could substantially reduce C-band traffic needs given that some traffic today relies on compression technology that is significantly less efficient than others. One analyst recently noted, "fully upgrading to the latest compression techniques would ultimately enable all existing C-band video channels to coexist using less than 20% of aggregate satellite capacity."[47] The significant benefits of this approach warrant the intensive work that would be involved.

Share, Where Appropriate. Because protected earth stations are stationary, the Commission should consider whether, on a limited basis, it should introduce co-channel sharing with sufficient geographic separation to prevent interference between flexible use licensees'

[45] CTIA Comments at 12.
[46] T-Mobile June 15 Ex Parte at 3.
[47] Kerrisdale Capital, *Intelsat S.A. & SES S.A.; To The Moon*, at 4 (June 2018) https://www.kerr-isdalecap.com/wp-content/uploads/2018/06/Intelsat-and-SES.pdf.

offerings and earth stations receivers. Most likely, protection areas surrounding an earth station would be too large to be feasible in urban or suburban areas. But with appropriate filters, this approach could work in some rural areas and could help further enhance the most efficient use of the C-band.

The Commission has substantial experience with each of these potential solutions, and a combined approach may be optimal.

3. The FCC Should Set Strict Timelines to Accomplish the Transition

This rulemaking process cannot drag on into the second half of 2019 and still result in rapid 5G deployment. To that end, the Commission should adopt tight timeframes for action under the market-based mechanism – 3-8 months for negotiation and a maximum of 12-20 months for clearing the band.[48]

The Commission should establish a backstop in the event that negotiations under the market-based mechanism approach get bogged down. If the Transition Facilitation Plan is not submitted according to the 3-8 month timeframe or otherwise runs into a significant delay, the Commission should impose a more traditional "clear and auction" approach. That approach would be less than ideal for the reasons explained above but will be necessary if our views about the more efficient nature of the market-based approach do not bear out. The Commission should spell out in its rules how that approach would work so that all parties understand the consequences of not following the timeline for implementing a market-based mechanism.

4. The FCC Should Review the Transition Facilitation Plan and Promptly Act on the Transfer of Flexible Use Licenses

The Commission should set specific benchmarks for completing its review of the Transition Facilitation Plan and should commit to prompt review and action on license

[48] *Notice* ¶¶ 82, 92.

assignment applications. And the Commission should "treat the Transition Facilitation Plan as an application for all the flexible use licenses" and allow "prospective licensees to file separate applications to transfer those licenses as the parties saw fit."[49] This approach will provide maximum flexibility by allowing each prospective licensee to move forward on its own schedule and not be delayed by a slower moving prospective licensee.

IV. A LIGHT TOUCH, FLEXIBLE RIGHTS, EXCLUSIVE USE LICENSING REGIME WILL BEST ADVANCE 5G IN THE 3.7-4.2 GHz BAND.

The Commission should apply the flexible use licensing framework it has embraced in other terrestrial fixed and mobile bands, enabling competition and market forces to drive investment, innovation, and deployment of next-generation wireless services. The bedrock policies incorporated therein – light-touch and symmetrical regulation across services – have proven immensely successful, resulting in innovation and intensive use of spectrum, all to the benefit of the American public and the economy. The Commission should follow that framework here as well.

Flexible Use Rights. The Commission should adopt its proposal to license this spectrum under its flexible rights Part 27 rules, which permit licensees to provide any mobile or fixed service, including point-to-point and point-to-multipoint transmissions.[50] This is the right approach generally, as it has been a key driver of the wireless industry's immense success in delivering innovation and benefits to the U.S. economy and to consumers. And flexible use is important in the 3.7-4.2 GHz band in particular, where 5G will unleash an enormous variety of services that will, for example, enable smart city technologies, connected cars, new capabilities for public safety, and new educational capabilities for schools.

[49] *Id.* ¶ 89.
[50] *Id.* ¶ 133, ¶ 143.

Block Sizes of 100 Megahertz. As noted above, the Commission should repurpose multiple blocks of 100 megahertz each. The *Notice* seeks input on block sizes that can "best accommodate the *fullest range* of terrestrial wireless services,"[51] and some 5G and other advanced services will require the faster speeds and low latency that can be delivered over 100 megahertz channels. The Commission has already adopted 100-megahertz channels in UMFUS spectrum "because this size would be consistent with developing industry standards that maximize spectral efficiency."[52] And here in the mid-band, other nations are licensing spectrum in 100 megahertz blocks.[53] Adopting that same approach for the U.S. will enable harmonized devices, in turn decreasing costs.

Unpaired configuration. To support advanced services, the channels should be unpaired so that they are suitable for Time Division Duplexing ("TDD"). This technology enables smart-antenna adaptive-beam technologies for highly directive antenna gain, and allows users to maximize flexibility to manage uplink and downlink traffic ratios. The Commission should refrain from adopting administrative measures to keep track of how spectrum blocks are being used, however.[54] Administrative measures are unnecessary; performance requirements (discussed below) are a more suitable backstop to ensure the spectrum is put to use.

Exclusive Geographic Licensing on an EA Basis. The Commission rightly observes that exclusive geographic area licensing "provides flexibility to licensees, promotes efficient spectrum use, and helps facilitate rapid assignment of licenses."[55] It also fosters investment and

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[51] *Id.* ¶ 135 (emphasis added).
[52] *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services*, Third Report and Order, Memorandum Opinion and Order and Third Further Notice of Proposed Rulemaking, FCC 18-73 at ¶ 57 (rel. June 8, 2018) ("*Spectrum Frontiers Third R&O*").
[53] *See supra* note 27.
[54] *Notice* ¶ 137.
[55] *Id.* ¶ 138.

innovation because licensees are assured the rights to mine the spectrum free of interference risks associated with competing use of the same spectrum.

Economic Areas ("EAs") are the most appropriate license sizes, because they provide the geographic scale to maximize investment and innovation in wide-area deployments of 5G and other advanced wireless services.[56] The Commission has chosen to award licenses using EAs in many bands including 700 MHz, AWS-1, AWS-4, and H Block,[57] concluding that doing so encourages widespread geographic buildout while providing large and small providers with sufficient flexibility to scale their networks.[58] These findings apply equally to the 3.7-4.2 GHz band. Indeed, the 3.7-4.2 GHz band offers a balanced alternative to the county-sized license areas recently adopted in the adjacent 3.5 GHz CBRS band.[59] Taken together, licensing mid-band spectrum in both larger and smaller license areas increases the options available for large and small operators, provides a wider choice of market sizes, and as a result, helps drive investment across mid-band spectrum.

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[56] *Id.* ¶ 139.

[57] *Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands*, Report and Order, 18 FCC Rcd 25162, 25176 ¶ 37 (2003) (stating economic areas "allow licensees to make adjustments to suit their individual needs"); *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102, 16121-22 ¶¶ 49-50 (2012) (stating economic area licenses "enable the proper balancing between encouraging wide-spread geographic build-out and providing licensees with sufficient flexibility" because they "can be aggregated up to larger license areas"); *Service Rules for Advanced Wireless Services H Block – Implementing Section 6401 of the Middle Class Tax Relief and Job Creation Act of 2012 Related to the 1915-1920 MHz and 1995-2000 MHz Bands*, Report and Order, 28 FCC Rcd 9483, 9500-01 ¶¶ 36-42 (2013) ("*AWS R&O*") (stating licensing on an EA basis helps the FCC achieve several statutory goals, including "providing for the efficient use of spectrum; encouraging deployment of wireless broadband services to consumers; and promoting investment in and rapid deployment of new technologies and services.").

[58] *AWS R&O*, 28 FCC Rcd at 9501 ¶ 42.

[59] *Promoting Investment in the 3550-3700 MHz Band*, Report and Order, FCC 18-149, at ¶ 9 (rel. Oct. 24, 2018).

A Robust Secondary Market. The Commission should adopt its proposal to extend its existing Part 1 and Part 27 rules permitting the leasing, partitioning and disaggregation of spectrum to the 3.7-4.2 GHz band.[60] These rules have proven to be effective in driving intensive use of spectrum by removing regulatory barriers to transactions. They enable licensees to tailor their spectrum holdings to align with their business plans and to differentiate their offerings from competitors. By facilitating a secondary market, these rules will enable the most intense use of the band, both spectrally and geographically.

Open Eligibility. The Commission should adopt an open eligibility standard, consistent with its approach for other wireless services.[61] Open eligibility maximizes the number of applicants for the spectrum, promotes competition that helps ensure the spectrum is put to its highest valued use, and encourages the development of different products and services. Here there is no basis to consider any eligibility restrictions.

Case-by-Case Review of Spectrum Acquisitions. There are no grounds to impose *ex ante* limits on the amount of spectrum one party can acquire through purchase or lease in the secondary market.[62] The Commission should instead conduct a case-by-case review of acquisitions of 3.7-4.2 GHz band spectrum. In the UMFUS bands, the Commission concluded that case-by-case reviews properly allow for the review of spectrum aggregation on market competition without unnecessarily restricting parties from acquiring spectrum to develop their business plans. Although the UMFUS rules include a spectrum threshold to identify markets that might warrant further competitive analysis, in such cases applicants are still evaluated under a

[60] *Notice* ¶ 143.
[61] *Id.* ¶ 145.
[62] As a general matter, across all spectrum bands, the Commission should not impose *ex ante* spectrum caps when assigning frequencies through competitive bidding. *Id.* ¶ 147.

case-by-case review.[63] And here, application of the CMRS spectrum screen is inappropriate,[64] given it is unclear the extent to which the spectrum would be used for CMRS or mobile telephony applications.[65]

15-year License Terms and Renewal Expectancy. The Commission should adopt its proposal to issue licenses on 15 year terms.[66] This period will provide sufficient time to encourage investment, driving faster and more expansive deployment. For investment purposes, a renewal expectancy is equally important. A 15-year license term coupled with a renewal expectancy is consistent with the Commission's rules for multiple other bands, including AWS-1, AWS-4 and most recently the UMFUS bands, and should be adopted here.

Performance Requirements. Verizon is generally supportive of performance requirements to ensure spectrum is put to use, but the proposed population coverage requirements here are more stringent than for other bands – including lower frequency bands with more favorable propagation characteristics. Specifically, the *Notice* proposes to require licensees offering mobile or point-to-multipoint service coverage of at least 45 percent of the population in the licensed area within six years, and to at least 80 percent within 12 years. No Part 27 service is subject to percentage levels this high.[67] The Commission does not explain why it proposed these more stringent service benchmark obligations, including a second benchmark at the 12-year point even though it proposes a 15-year license term, or how the proposal comports with the principle of regulatory symmetry across wireless services. Lower benchmarks – no

[63] *Id.* ¶ 34 (adopting case-by-case review for acquisition of spectrum in five UMFUS bands).
[64] *Id.* ¶ 148.
[65] *See Above 24 GHz R&O*, 31 FCC Rcd at 8081-82 ¶¶ 183-185.
[66] *Notice* ¶ 149.
[67] For example, in the lower frequency bands 700 MHz Upper C and AWS-3, licensees must offer service to 40 percent of the population for the interim performance requirement and 75 percent for the final performance requirement.

higher than those adopted for the 700 MHz Upper C Band and the AWS-3 band, which propagate better than C-band – are more appropriate. And the final benchmark should be set at the end of the initial license term, as is the case with performance requirements for most other bands.

The Commission should also adopt an alternative geographic coverage requirement that may be more suitable for some Internet of Things or low-power services that are not designed to cover residential populations.[68] The Commission recently adopted this same approach for the UMFUS bands, finding that alternative geographic coverage requirements provide licensees with flexibility that will encourage them to offer innovative services while achieving the objective that spectrum is put to use.[69]

The Commission should refrain from adopting the proposal that, if a licensee fails to meet the final benchmark, the authorization terminates automatically.[70] While the penalty for not meeting the interim benchmark is appropriate, terminating the license where the licensee falls short of meeting the final benchmark is unnecessarily harsh, particularly if the Commission adopts a very stringent coverage requirement (even 75 percent of licensed area population). A licensee that invests in a network to serve 74 percent of the population by the end of its term would lose its entire license, disrupting service to nearly three quarters of the population. The Commission should instead recapture the unserved portions of a licensed area, consistent with the approach the Commission took for the 700 MHz band.[71]

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[68] *Id.* ¶¶ 154-156.
[69] *Spectrum Frontiers Third R&O* ¶¶ 8-9.
[70] *Notice* ¶ 157.
[71] *See* 47 C.F.R. § 27.14(g), (h) (if 700 MHz licensee does not satisfy final performance requirement, authorization will terminate "for those geographic portions of its license in which the licensee is not providing service.").

The Commission also seeks comment on whether to adopt additional performance requirements for subsequent license terms and if so, what those requirements should be.[72] As the Commission notes, however, it is separately considering whether more stringent buildout obligations post-initial term should be adopted for all wireless services.[73] One of the reasons the Commission initiated that proceeding was to adopt uniform rules that were harmonized across different services. That is the proper policy objective – and it militates against developing specific performance requirements for subsequent license terms in the 3.7-4.2 GHz band.

V. TECHNICAL RULES HARMONIZED WITH OTHER FLEXIBLE USE SERVICES WILL GENERALLY ENABLE 5G TO FLOURISH WHILE ENSURING CO-EXISTENCE WITH OTHER OPERATIONS.

The Commission's proposal to apply many of the existing Part 27 technical rules to the 3.7-4.2 GHz band makes sense. As the Commission has acknowledged, harmonized rules across bands serve the public interest by ensuring that market forces, not the disparate impact of varying rules, drive the growth of wireless services. [74]

Power Limits for Fixed and Base Stations. The Commission should adopt the proposed limits of 1640 watts EIRP per megahertz, with double that level (3280 watts EIRP per megahertz) in rural areas, which are the same as those that apply to other bands including the AWS-1, AWS-3 and AWS-4 bands.[75] As the Commission previously found, higher power limits in rural areas will promote broader coverage in those areas by reducing the number of cell sites that must be constructed. Given the wide bandwidths that are expected to be used, Verizon supports the proposal for an overall total power of 75 dBm ERP for base stations, summed over

[72] *Notice* ¶¶ 160-161.
[73] *Wireless Reform Order*, 32 FCC Rcd at 8911-12 ¶¶ 100-104.
[74] *See e.g.*, *id.* at 8875 ¶ 1.
[75] *Notice* ¶ 164.

all antenna elements.[76] The Commission should also adopt its proposed power limit of 1 watt for mobile and portable devices,[77] which will enable providers to work with their vendors to design devices that can best provide the types of services they choose to offer in the marketplace.

Out of Band Emission Limits. The Commission should extend its "longstanding" OOBE limit of -13 dBm/MHz at the authorized channel edge to the 3.7-4.2 GHz band, finding that it "will provide protection to incumbent services in adjacent bands, while allowing the full use of the new band."[78] This limit will protect adjacent operations and should be adopted. While the *Notice* alternatively seeks comment on a more stringent OOBE limit beyond the edges of the band,[79] it does not set forth a technical rationale that would warrant imposing it. The Commission should also adopt the resolution bandwidth it applied in most AWS bands to determine compliance with the -13 dBm/MHz limit, as AWS frequencies are more adjacent than UMFUS bands, which have a different resolution bandwidth. It should also adopt the same OOBE limit for mobile devices.[80]

Coexistence with FSS Stations. The principal issue related to coexistence with Fixed Satellite Service ("FSS") involves adjacent band FSS operations above the mid-band flexible use spectrum. On this issue, the Commission should be guided by two goals: maximizing the amount of spectrum to be repurposed for flexible use and protecting earth stations that remain in the upper portion of the band. In practice, this means minimizing any necessary guard band and – importantly – directing the Transition Facilitator to obtain and, for each remaining earth station, install the sharpest filters available. The *Notice* reflects that satellite operators are

[76] *Id.* ¶ 165.
[77] *Id.* ¶ 167.
[78] *Id.* ¶ 168.
[79] *Id.* ¶¶ 168-169.
[80] *Id.* ¶ 168, ¶¶ 170-171.

already engaged with manufacturers to define the desired filter characteristics.[81] The Commission should drive this process by adopting a minimal guard band of no more than 20 MHz and allowing the marketplace to develop filtering technology given the allowed transmit power level and out of band emission limits identified above.[82]

The *Notice* also observes that there may be some earth stations that operate co-channel with new flexible use licenses.[83] In this instance, coordination zones may be necessary but the size of those zones will relate to the filters installed at the earth stations. Again, the Commission should press the Transition Facilitator to install the most stringent filtering technology available to reduce the size of coordination zones.

The *Notice* also recognizes that there are 120 earth stations authorized immediately below 3.7 GHz, in the 3600-3700 MHz band.[84] The Commission asks, "[g]iven that there will be no guard band to help prevent interference in this band, should operators of these stations be included in any transition mechanisms…?"[85] To the extent that these operators are receiving programing from the same C-band satellite operators, to maximize the amount of spectrum repurposed for flexible use, the Transition Facilitation Plan should include these 120 earth stations in its plans to protect earth stations in the in the 3.7-4.2 GHz band.

Coexistence with CBRS Operations. The *Notice* also observes that mid-band flexible use operations will be adjacent to the Citizens Band Radio Service ("CBRS") below 3.7 GHz,[86] specifically General Authorized Access ("GAA") operations located in the upper portion of the

[81] *Id.* ¶ 172.
[82] *Id.* ¶ 174.
[83] *Id.* ¶ 176.
[84] *Id.* ¶ 177.
[85] *Id.*
[86] *Id.* ¶ 181.

CBRS 3.5 GHz band. The Commission may need to consider whether to adopt a guard band to protect the flexible use operations.

Field Strength Limits at Market Boundaries. The Commission should adopt its proposal to apply the same -76 dBm/M^2/MHz power flux density limit at the flexible use licensee's service area boundaries that it adopted for the UMFUS bands and permit licenses to voluntarily agree on higher field strength levels, as it has done for other bands.[87] These technical rules will promote market-based solutions that will maximize efficient spectrum use and help achieve reliable service along market boundaries.

Antenna height limits. The Commission should adopt its proposal to extend the flexible antenna height rules that apply to the AWS-1 and AWS-3 bands to operations in the new mid-band flexible use spectrum.[88] This approach does not set specific maximum heights, but allows licensees to deploy their networks for optimal coverage and use. Licensees will still need to comply with the Part 17 rules governing hazards to air navigation and with field strength limits at market and international boundaries, which may as a practical matter limit some antenna heights, but otherwise they will have flexibility to maximize service coverage and reliability.

[87] *Id.* ¶¶ 182-185.
[88] *Id.* ¶ 186.

VI. CONCLUSION.

Making available more mid-band spectrum is critical to meet the public's ever-increasing demand for advanced services, and to the United States' ability to continue its leadership in the race to 5G. The Commission should move quickly to repurpose and license 3.7-4.2 GHz spectrum for flexible use, while also accommodating today's C-Band traffic without disruption.

Respectfully submitted,

/s/

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October 29, 2018

ATTACHMENT:

Assessment of Proposed C-Band Mechanisms, Professor Daniel R. Vincent

Assessment of Proposed C-Band Mechanisms

Daniel R. Vincent

October 22, 2018

Introduction

My name is Daniel R. Vincent. I am Professor of Economics at the University of Maryland, College Park where I teach graduate courses in microeconomic theory and industrial organization. I am an economic theorist with a specialization in auction theory and market design. I have published scholarly articles in this area in top economic journals and in policy forums. I served as advisor to the FCC in their evaluation of the performance of the initial major SMR auctions for PCS licenses. I was a member of an outside consulting team (Market Design Incorporated) that provided early models of combinatorial auctions for spectrum. Additionally, I have advised the FCC and Industry Canada, as well as other government agencies on the design of spectrum auctions. I have also provided advice to bidders participating in such auctions. I have served as consultant for the US Department of Justice Antitrust Division and for a variety of third parties on antitrust matters.

Verizon asked me to review the five proposals for repurposing C-Band spectrum outlined in "Expanding Flexible Use of the 3.7 to 4.2 GHz Band**", Order and Notice of Proposed Rulemaking - GN Docket No. 18-122,** (NPRM). In this paper, I describe some of the challenges faced by the FCC in achieving this goal and comment on the ability of the proposed mechanisms to meet these challenges. As many of the proposals remain only partially characterized, this analysis is necessarily incomplete.

Overview

In repurposing the 3.7-4.2 GHz band, or the C-Band, four separate tasks must be completed, each of which poses complex issues.

A) Determining an *amount* of the 3.7-4.2 MHz band that will be repurposed for flexible use: this step is complicated not simply because there are incumbent satellite licensees with rights in this band but because all licensees have rights to the whole band. Thus, any voluntary scheme would require finding a way to get all or most of these incumbents to agree. Furthermore, the intensity of use by incumbents varies over the geography of the U.S., and so it must be determined whether the amount of repurposed spectrum should be uniform nationwide. An additional complication involves addressing the interests of Earth Station (ES) users, who are independent from the incumbent satellite licensees.

B) Finding a way to *compensate* incumbent satellite licensees for yielding some of their rights: typically, we would use direct compensation as a means to induce voluntary ceding of rights in Task A. However, while all licensees share equal rights to the whole spectrum, not all licensees appear to use the spectrum equally. Furthermore, ES interests in the spectrum are derived from incumbent satellite licensees' activities and, again, the question arises as to how the ES interests will be accommodated or compensated.

C) Finding a way to *assign* repurposed spectrum among new licensees: Should this be done via an auction or via negotiation? Given heterogeneity of incumbent use in various areas, the speed at

which the band can be cleared may itself be a subject of negotiation making a definition of the product to be sold difficult.

D) Finding a way to *generate* enough revenue to pay for the compensation required in Task B: Ideally, this would be achieved as part of Task C.

Compared to previous auctions, the repurposing of the C-Band poses two unique problems. Because the incumbent satellite licensees own rights to the use of the full band, a mechanism must be found to get all of them to yield rights for any part of the spectrum that is to be cleared. This fact rules out the use of standard reverse auctions. Related to but distinct from this problem is the fact that the incumbent users of the band have very diverse needs that may involve different intensities of use and different timing of contracts across different geographical areas. Thus, clearing spectrum in a given area may involve a variety of time frames and levels of encumbrances. This fact limits the ability to provide a uniform description of a repurposed spectrum license that is usually employed in a forward auction. An additional issue which is not unique to the C-Band repurposing but may be especially important in this application is the need to complete the process quickly so that valuable new uses of this spectrum are not unduly delayed. My comments on the various proposals center on how well they address these key hurdles.

Proposals

I. Market Based Mechanism

The market based mechanism is the most fully described approach in the NPRM. Under this approach, satellite operators would be responsible for coordinating stakeholders and clearing spectrum. These tasks would be performed by a "Transition Facilitator" (TF) which represents the interests of the satellite owners jointly. This body would be responsible for determining the amount of spectrum to be cleared (in each geographical area), the price new licensees would pay for the cleared spectrum, the timing of clearing and the compensation that would be paid or accommodations provided to ES operators due to repurposing this band.[1]

As described in the NPRM, the approach would proceed in four steps:

1) TF formation – The charter is established as well as the structure, objectives and operations. All of this is reported to FCC which has 60 days to file an objection. Questions such as whether to require all FSS operators to participate or how ES operators will be compensated or accommodated are not yet determined but would probably have to be specified at this step.
2) Negotiation Period – Negotiation with prospective licensees and ESs to determine the "profit-maximizing" amount and price of spectrum to be repurposed.[2] This process will result in a quantity of spectrum to be repurposed, potential licensees and a mechanism for compensating

[1] The two major satellite operators, Inteslat and SES, and Eutelsat as well as Intel, Cisco, Enlace (ES), Alphastar are listed as in favor of this proposal. T-Mobile opposed it. (¶¶ 68, 69, 74). On October 1, 2018 Intelsat, SES, Eutelsat and Telesat announced the formation of the C-Band Alliance (CBA), a consortium to facilitate clearing of U.S. 3.7-4.2 GHz spectrum for 5G which will take on the role of Transition Facilitator.

[2] The phrase "profit-maximizing" is from NPRM ¶ 80.

or accommodating ESs.[3] The NPRM, based on Intelsat and SES filings, projects that this step can be completed in 3-8 months.

3) Conditional Authorization of licenses – FCC is presented with plan for transition and applications for license transfer. From 2 to 7 months are projected for this step.
4) Band is cleared – 12-20 months for incumbents to cease operating in repurposed spectrum. The TF has the responsibility for ensuring agreements are carried out.

This proposal is the most fully worked out of the five proposals in the NPRM and therefore it is possible to conceive more fully how it would proceed. The emphasis on forming a consortium of most of the satellite operators makes it plausible that any solution to the issues laid out in Tasks A-D above will be achieved by consensus on the part at least of most of these operators.

The reliance on bilateral negotiations between the TF and potential purchasers of spectrum allows an important degree of flexibility across buyers and across geographic areas. For example, one buyer might be willing to pay significantly more for spectrum in a given market if it can be cleared very quickly, and another might be willing to wait for a longer period in return for a lower price. For purchasers of multiple licenses, differing trade-offs in clearing time and price across these licenses offer more opportunities to construct an appropriate overall portfolio and to more rapidly reach an agreement. Thus, this approach directly addresses the problem of non-uniformity of licenses. The costs and difficulties of clearing spectrum could help determine which buyer would be appropriate. In some geographic areas, current 3.7-4.2 GHz satellite use may be easily substituted with alternative means of delivery and therefore spectrum could be cleared faster or more spectrum could be cleared.

Furthermore, to the extent that both firms that upload data to the satellites and the ESs that receive data must interact with the operators, these operators (and through them, the TF) may be in the best position to determine the nature and extent of satellite-delivered traffic and how that traffic can best be accommodated or moved to a different band.

Although the proposal sets out a timeline for an initial clearing of spectrum, the NPRM explicitly notes that the process can be ongoing.[4] Thus, while some of the other proposals anticipate a discrete one-time clearing event, this proposal sets out a process that allows for further spectrum clearing over time as the need for satellite use of the band declines. This is especially important as it is foreseen that there is currently significant diversity across geographic markets in terms of the importance of C-Band delivery. This demand will likely change at different rates in each market.

Additionally, as long as buyers of spectrum have varying geographic footprint needs, it is plausible that bilateral negotiations between the TF and individual buyers would be more likely to achieve these goals as the scope of geographic coverage can become part of the conditions of any deal.

Finally, this approach requires relatively little intervention or rule-making by the FCC and, for that reason, might be expected to conclude much more quickly. At the very least, the satellite consortium has committed to a specific timetable to achieve these goals.

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[3] In its submissions, Intelsat projected 100MHz of spectrum could be cleared and projects 3-8 months to completion. Intel claims that more spectrum can be cleared and more recently, on October 22, the CBA announced that "up to 200 MHz of mid-band (C-Band downlink) spectrum could be cleared...."

[4] See NPRM ¶ 72.

The fact that both the price of cleared spectrum and the quantity of cleared spectrum will be determined through the negotiation process yields the TF a great deal of informational and supply-side power. This feature could put the potential purchasers of spectrum in a weak negotiating position. As the NPRM suggests, it would be more appealing to have some feature by which, at Step 1, target amounts of cleared spectrum are committed to before negotiations take place in Step 2, which could be done by FCC action. This could involve both minimum and potential maximum targets of amounts of spectrum to be cleared in each geographic region. The recent announcement by the CBA to clear up to 200 MHz of spectrum is a good step in this direction, however, a commitment to a minimum amount along with a recognition that in many areas more spectrum can be cleared would further address this problem. Additionally, if the timing and nature of clearance of certain parts of the band varies and will form conditions of any transaction, these features could be made public before negotiations are engaged in.

II. Hybrid Mechanism

T-Mobile has offered what the FCC describes as a hybrid mechanism in that it is to some degree a blend of the approach used in the Broadcast Incentive Auction (BIA) and the market based mechanism. One modification from the Broadcast Incentive Auction lies in the timing. Unlike the BIA, a forward auction is conducted first on the supposition that the full band is cleared in (almost) every geographic license area.[5] The auction occurs simultaneously and generates a price in every region for clearing the full spectrum. With prices for each geographic license area known, incumbent satellite licensees "bid" to supply the spectrum. This stage pictures the satellite operators operating as a single entity (in a manner similar to the TF) which selects which areas the operators would be willing to vacate the full spectrum given the prices from the forward auction. The mechanism then proceeds in stages, in each stage and for the remaining uncleared geographic license areas, successively lower amounts of spectrum will be auctioned until the process reaches a minimal amount determined by the FCC that must be cleared. Revenues generated by this approach will be shared by the satellite operators and the FCC with the former holding the responsibility for compensating or accommodating ES operators to accommodate the loss of spectrum. T-Mobile suggests offering a sliding scale in compensation with lower compensation percentages returning to the satellite consortium as the quantity of spectrum clears falls. This variant is intended to counter the incentive of the consortium to restrict output in order to raise total revenues.

A positive feature of this proposal is that, because of the timing and because of the explicit auction structure, some of the sell-side advantage of the satellite operators is reduced. In effect, for a particular clearing quantity, the buying side of the market, through its behavior in the forward auction stage, makes a kind of joint take it or leave it offer to the satellite operators. If the operators choose not to accept the prices on offer at this stage, they must accept the risk of waiting for a lower amount of spectrum to be cleared with, potentially, lower revenues.

The hybrid mechanism has a number of weakness as well, however. This proposal does not explicitly describe how the decision process for the satellite operators would work. Somehow, the many operators would need to come to a consensus agreement, at each stage and for each remaining geographic license area, whether to accept or reject the prices from the immediately preceding stage of

[5] A limited number of "Satellite Designated Zones" would be allowed where in some areas satellite operations will be allowed to continue.

the forward auction. It is possible that a Transition Facilitator-like entity would play that role here, as it does in the market mechanism.[6] The market mechanism, however, offers more flexibility in how to accommodate the diverse interests of satellite operators and therefore might be more successful at reaching a consensus among them.

Although this approach enables flexibility in terms of the quantity of cleared spectrum across licensed geographic areas, the auction format is not very conducive to other forms of flexibility that might be required, such as clearing timing and encumbrances. It would be more complex though not impossible to operate a forward auction with many different types of spectrum products, varying say by the degree of encumbrance, or timing of clearance in each given licensed area. Doing so would reduce the ability to utilize a generic auction as envisaged by the hybrid proposal. And, it would be even more complex to have bidders bid on multiple dimensions of these types. The market-based mechanism appears to be much more capable of managing transactions where there are many dimensions over which to negotiate. Furthermore, the hybrid proposal is essentially a one-shot mechanism that is less conducive to operating on a continuing basis to allow for repurposing yet more spectrum as the needs of both sides of the market evolve.

The reverse timing feature of this mechanism makes it possible for large amounts of spectrum to be cleared, however, it also introduces a lot of uncertainty for wireless buyers about the ultimate amount of spectrum they will obtain that may render this possibility unattainable. Buyers with specific footprint targets may have difficulty determining how much to bid in early stages of the auction since they cannot be sure of how much spectrum ultimately will be cleared. For example, a bidder that needs to acquire a license in both areas A and B may be reluctant to bid aggressively for A in any given stage if it is uncertain whether the satellite operators will be willing to clear sufficient spectrum in B for it to be able to purchase it and vice versa. This is another instance of the "exposure problem" that often emerges in multi-unit auctions but is exacerbated here because of the additional uncertainty coming from the supply side behavior.

III. Auction Mechanisms

The FCC describes three proposals based on FCC-led auctions to implement repurposing of the spectrum. As the new use of spectrum involves the assignment of exclusive rights, all of the proposals effectively involve a standard forward auction on the buy side. They generally differ in how to treat the supply side and thus how they address the two key hurdles described in the introduction. In an overlay auction, following the auction, inducing the supply of spectrum would be the responsibility of one or more overlay licensees via negotiations with incumbent satellite licensees. In an incentive auction, supply would be determined through the use of some form of mechanism based on the theory of the optimal provision of public goods. In a capacity auction, supply is determined by first inducing incumbents to voluntarily give up their use of spectrum capacity in return for payment and then having the FCC "repack" any remaining incumbents into a smaller amount of spectrum in the band. These proposals are expanded upon below.

[6] In its Ex Parte (June 15, 2018, p. 5), T-Mobile envisions the creation of a "satellite consortium" of all satellite licensees but does not detail the process by which agreement is reached among the satellite operators.

A) Overlay Auction

Under this approach, residual rights to flexible use of the spectrum would be acquired, through a bidding process, by one or more "overlay" licensees. Each overlay licensee would have to respect the rights to the use of the spectrum by current incumbents until it came to a negotiated agreement with all the incumbents to cede some or all of those rights. It might also be responsible for selling in a secondary market additional licenses for flexible use if the FCC did not wish a single licensee to acquire flexible use rights for its spectrum in this band or if it was not an end user of spectrum.

To some extent, the market-based mechanism could be viewed as a special case of this approach where the holder of the overlay license is the TF.[7] An overlay auction is more general, however, in that it broadens the pool of candidate agents beyond the satellite operators as potential coordinators of spectrum supply in the hope that agents who are not incumbent licensees might bring more innovative approaches to finding ways to clear the spectrum.[8]

Little detail is provided as to how this proposal would operate outside the observation that the overlay licensee would be determined through competitive bidding. The idea is that by allocating the residual rights to one agent, which would have the opportunity to benefit from any spectrum that is ultimately cleared (either through its own use or through sale to other users), an incentive is created to find effective and efficient ways to overcome many of the hurdles involved in the process.

An alternative variant of this approach could be to sell one or more overlay licenses (for example in 100 MHz blocks) to terrestrial wireless firms, each of which would then negotiate with all the satellite operators (and possibly other stakeholders) all of whom would need to agree to yield spectrum. If the satellite operators were allowed to form a consortium to conduct the negotiations, then, again, this proposal would mirror the market-based mechanism with one difference: in the market-based mechanism, the TF would have freedom to negotiate with any potential purchaser. In the overlay auction, the consortium could only negotiate with the overlay licensee(s) determined by the forward auction.

Since the ultimate clearing becomes the responsibility of the overlay licensee in negotiation with the incumbent licensees, the terms of clearing agreements can be flexible both in timing and quantity across geographical areas.

The observation that the market-based mechanism could be viewed as a special case of the overlay illustrates that the proposal adds a further layer of complexity and delay to the approach. That is, even if the ultimate outcome is that an entity representing the satellite operators obtains the overlay license, the approach requires establishing an auction (along with all of its rules and procedures) before any negotiations can take place.

By its very nature, an overlay auction presents the potential for raising revenues for the Treasury. Nevertheless, there are also factors that suggest these revenues will not be large. Overlay licensee(s)

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[7] Although the NPRM suggests prohibiting satellite operators from forming a bidding consortium for the overlay license, if a single satellite operator acquired the license, it could still choose to act in the same fashion as a TF. If it did not, and instead operated solely in its own private interests, it seems unlikely that it would find it easy to come to an agreement with its erstwhile competing satellite rivals.

[8] See NPRM ¶ 101.

could also be subject to the exercise of hold-up strategies by the incumbent licensees. Having paid for a license in the overlay auction, an overlay licensee can only recoup its investment if the incumbent licensees agree to vacate that part of the band. Depending on the balance of bargaining power among the agents, the anticipation of this threat could result in an unwillingness for prospective overlay licensees to risk an upfront investment of any sort in the overlay auction.

The proposal is silent about the responsibilities of the overlay licensee which could raise difficulties. For example, if only a single wireless operator were to acquire a single overlay license for the entire band, it would then presumably be expected to engage in good faith negotiations with its rival operators. The FCC would need to establish procedures by which this process would take place.

B) Incentive Auction

This approach adapts the ideas behind the Broadcast Incentive Auction to allow two sides, supply and demand, to jointly bid to clear spectrum. The complication here is that, since all potential suppliers own rights to all the spectrum, the reverse auction component would have to be significantly modified. Although the scheme is not fully described, one possibility is a mechanism mirroring proposed schemes for the selection and provision of a public good. As an example of such schemes, a discrete collection of possible alternatives are listed: Alternative A) free up 100MHz and concentrate satellite operations on the remaining part of the band; Alternative B) free up 200MHz and concentrate satellite operations on the remaining part of the band, and migrate some operations to a different band or fiber or other clearing mechanisms; Alternative C) Free up the whole band and migrate operations to a different band or fiber or other clearing mechanisms. Incumbent satellite licensees would then bid in a carefully selected mechanism over all these choices. Under ideal circumstances, this bidding would reveal the true social costs of selecting each alternative. Each alternative differs in the amount of freed spectrum and total cost of achieving it, and a forward auction would then select which of the alternatives to implement by determining which alternative can be paid for by the forward auction revenues.

In simpler environments, it is possible to design schemes which induce truthful behavior by the suppliers. This environment is more complicated since it is not obvious that the schemes we understand best extend easily to cases where the amount of money required by suppliers to yield spectrum, the amount of money demanders are willing to pay for spectrum and the total amount of spectrum to be cleared all have to be determined. At an abstract level, the sense is that something like a supply curve would come from the reverse auction and something like a demand curve would come from the forward auction, then some criteria would be used to select from the feasible alternatives if there are more than one, and some process that would be part of the reverse auction mechanism both to incentivize and to compensate the suppliers.

Even in the most favorable of circumstances, a mechanism like this can really be thought of as an experiment. Although, from a broader perspective there is value to undertaking a diverse variety of approaches in order to see how they perform, this asset may be too valuable to risk on an experiment. And, it is unlikely that “the most favorable of circumstances” applies here.

Which outcome is appropriate and possibly even what options are considered would likely vary across geographical areas. For reasons of sheer complexity, it is unlikely that a sophisticated mechanism like this could work on, say, a geographic area by area basis, so many compromises would have to be made to render it implementable.

This scheme appears to be workable only through the design and oversight of FCC. Given its novel nature and its speculative characteristic, public debate and the need to acquire input over the rules likely would involve a long process before implementation.

C) Capacity Auction

A capacity auction operates by converting the joint (public good) ownership of spectrum into the private ownership feature of capacity. Users of capacity in the C-Band offer to give up capacity in this band. As capacity use falls, the market-wide need for spectrum for satellite use in the C-Band should fall. (Whereas before, with capacity level, X, the full 500MHz was needed, now with capacity level X-K, say, only 400MHz may be needed.) The reduced capacity that would then be needed could be concentrated on a narrower part of the band (in the example, presumably the upper 400MHz). Transponders used for the lower 100MHz would be no longer needed and would be shut down. Satellite owners with these as stranded assets would have to be compensated in some manner for giving them up (those who voluntarily give up capacity will already have been compensated as part of the transaction in the capacity auction, for those who are not voluntarily giving up capacity, there must be some other process to make them whole.)[9]

Once, say, K units of capacity are yielded in a reverse auction, the FCC then will unilaterally try to clear some amount of spectrum by conducting a forward auction to see if the revenues are enough to pay the providers of capacity. If so, that part of the band is cleared. This process shares some features of the BIA in that once some overall capacity is given up, a type of "repacking" is then imposed by the FCC to move the remaining users of capacity into a more concentrated portion of the band and clear a contiguous part for repurposing. If insufficient revenues are obtained to clear this capacity, then presumably a smaller amount of capacity will be auctioned in an iterative fashion similar to the BIA.

It is not clear how the proposal would deal with satellite operators without excess capacity in higher frequencies. For example, suppose Operators A through G bid to give up enough capacity to clear 100MHz of spectrum but Operator H did not and H requires the full 500MHz to serve its customers (all its transponders are currently utilized). Where can H shift the customers who are using the lower 100MHz? Conceivably, since there now is excess capacity in the whole market, it would be feasible for it to subcontract with A or another operator to shift its lower frequency customers to this use but whether and how this would be done is not made clear.

The sparse description of many details of the proposal, however, make it difficult to fully evaluate. There is a sense in which, by opening up the reverse auction to "users" of capacity beyond the satellite operators, such as ESs and satellite customers, the mechanism broadens the source of supply and thus reduces the seller power of the satellite operators compared to the market-based mechanism. However,

[9] It is possible that other users of capacity could also bid in the supply part of the auction. For example, if, say, a content provider which currently contracts for a certain amount of capacity through the band per year chooses to take some of that capacity off the satellites (perhaps by compressing its signal or perhaps by finding a different mode of delivery), it could be paid to do so in the capacity auction. Depending on contractual terms, the content provider may still need to pay a satellite operator according to the contracted terms (and part of the capacity auction compensation would pay it for that expense), however, with that demand no longer used in the band, the FCC will feel justified in clearing some spectrum associated with it. See the discussion in NPRM ¶ 106.

it is not made very clear how such other users could be identified and verified as bona fide potential suppliers of capacity.

In addressing the public goods problem by auctioning private capacity, the proposal replaces one auction related problem with another problem that is familiar from the package auctions – the threshold problem. Incumbent licensees in this auction may only be successful in offering capacity if other licensees also offer capacity. Suppose there were only two satellite operators and they each needed to yield K units of capacity in order to clear 100MHz for which a new licensee would pay $1M. Consider auctioning capacity by a descending price auction (the reverse auction analog of an ascending bid forward auction). Each operator would like to halt its offer at a high price, say $800K in order to force the other to accept a lower price. In this circumstance, each bidder is being asked to privately provide the "public good" of accepting a lower price and it is not clear that either would willingly do so.

It also is not explained how the FCC would determine how much spectrum to clear given a certain amount of capacity provided at the auction. There may be a direct engineering relationship between a given quantity of capacity yielded but the choice of clearing amounts will likely become a contentious issue. Additionally, the FCC would have to determine the amount of spectrum to be yielded and clear it by fiat. Since at least some satellite operators and other stake-holders will not likely have offered their capacity, the lack of voluntary participation would generate resistance.

This proposal requires very active involvement by the FCC including involuntarily clearing some operators off spectrum. Coming up with rules to do so would likely be a very time-consuming process thus this proposal appears likely to involve a significant delay before spectrum is repurposed.